FirstEnergy

Davis-Besse Nuclear Power Station
5501 North State Route 2
Oak Harbor, Ohio 43449-9760

NP-33-03-003-00

Docket No. 50-346

License No. NPF-3
June 10, 2003

United States Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Ladies and Gentlemen:

LER 2003-003
Davis-Besse Nuclear Power Station, Unit No. 1
Date of Occurrence – September 25, 2002

Enclosed please find Licensee Event Report 2003-003, which is being submitted to provide written notification of an issue with the High Pressure Injection (HPI) pumps during postulated very small break loss of coolant accident events. The postulated analytical conditions predict pump operability concerns due to the potential for pump deadheading. An eight-hour immediate notification of this issue was made to the NRC on April 11, 2003 (Event Number 39750). This LER is being submitted in accordance with 10 CFR 50.46(a)(3)(ii), 10CFR50.73(a)(2)(ii)(B), 10CFR50.73(a)(2)(v), and 10CFR50.73(a)(2)(vii).

Very truly yours,

Mark B. Bezilla
Vice President

PSJ/s

Enclosures

cc: Mr. J. E. Dyer, Regional Administrator, USNRC Region III
Mr. C. S. Thomas, DB-1 NRC Senior Resident Inspector
Utility Radiological Safety Board

IE22

COMMITMENT LIST

The following list identifies those actions committed to by the Davis-Besse Nuclear Power Station in this document. Any other actions discussed in the submittal represent intended or planned actions by Davis-Besse. They are described only as information and are not regulatory commitments. Please notify the Manager - Regulatory Affairs (419-321-8450) at Davis-Besse of any questions regarding this document or associated regulatory commitments.

Commitment	DUE DATE
Review response to Item #2 of DBNPS Letter Serial 568 dated December 28, 1979 and revise as necessary.	September 30, 2003

NRC FORM 366 (7-2001)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

APPROVED BY OMB NO. 3150-0104 EXPIRES 7-31-2004

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
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4. TITLE

Potential Inadequate HPI Pump Minimum Recirculation Flow Following SBLOCA

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER 05000
9	25	02	2003	– 003 –	00	6	10	2003	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE: D

10. POWER LEVEL: 000

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

	20.2201(b)		20.2203(a)(3)(ii)	X	50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)		50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)	X	50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)		50.36(c)(2)	X	50.73(a)(2)(v)(B)	X	OTHER Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		
	20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)	X	50.73(a)(2)(v)(D)		
	20.2203(a)(2)(v)		50.73(a)(2)(i)(B)	X	50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
	20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER (Include Area Code)
Peter S. Jordan – Regulatory Affairs	(419) 321-8260

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX

14. SUPPLEMENTAL REPORT EXPECTED				15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
X	YES (If yes, complete EXPECTED SUBMISSION DATE).		No		8	9	2003

16. ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

The High Pressure Injection (HPI) Pumps are components of the Emergency Core Cooling System (ECCS) which is required to maintain core cooling following postulated accidents. In September 2002, a question was raised regarding the minimum flow protection of the pumps when the recirculation valves are closed upon pump realignment to the containment emergency sump. The investigation of this issue identified a subset of very small break loss of coolant accidents (SBLOCA) that can result in cyclic repressurization of the Reactor Coolant System in excess of the shut-off head of the pumps which may result in pump damage. Considering the highly conservative ECCS analytical assumptions required by 10CFR50.46, this condition would render the ECCS inoperable. However, operation of other highly reliable but non-safety grade equipment in accordance with approved emergency operating procedures would easily mitigate the consequences of the very SBLOCA sequences. Evaluation of this issue continues. This condition of analytical results and postulated consequences is being reported as a change in ECCS performance as predicted by the 50.46 analysis per 50.46(a)(3)(ii), a condition resulting in an unanalyzed condition per 50.73(a)(2)(ii)(B), a loss of safety function per 50.73(a)(2)(v), and creation of a common mode failure per 50.73(a)(2)(vii).

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

DESCRIPTION OF OCCURRENCE:

Davis Besse Nuclear Power Station (DBNPS) was designed with two fully redundant High Pressure Injection (HPI)[BQ] trains whose function, in cooperation with other components, is to provide reactor core cooling following postulated accidents. Immediately following the onset of a loss of coolant accident(LOCA), the HPI pumps' [BQ-P] suction would be aligned to the Borated Water Storage Tank (BWST) to inject water into the core. In the case of certain small break LOCAs (SBLOCAs), during the initial phase of the accident, the Reactor Coolant System (RCS)[AB] may not be sufficiently depressurized to allow HPI pump injection. To protect the pumps in this shutoff head (and potential overheating) condition, a minimum flow line is open to allow recirculation of approximately 35 gallons per minute (gpm) back to the BWST. When the BWST inventory is nearing depletion, procedures require that HPI pumps be realigned to take suction from the containment emergency sump via the LPI pump discharge. Prior to this realignment, operators are required to close the valves in the pumps' recirculation lines. This action is to prevent potentially contaminated fluid from the emergency sump from being pumped to the BWST which may result in emergency sump inventory loss and offsite dose exceeding 10 CFR 100 limits. When the realignment of pump suction occurs, the HPI pumps are operated in "piggy-back" with the Low Pressure Injection(LPI)/Decay Heat (DH)[BP-P] pumps. In this configuration, the LPI/DH pumps act as booster pumps to the HPI pumps, and RCS pressure should be maintained below approximately 1750 psia in order to ensure that the HPI pumps will have adequate minimum flow rates needed for continuous operation.

In the fall of 2002, the NRC conducted a special inspection of activities described in the "Davis-Besse System Health Assurance Plan." This inspection included an in-depth review of the design and performance capability of the HPI System. During this review, an inspector questioned the spectrum of breaks included in the SBLOCA analyses. This is documented in NRC Inspection Report 50-346/02-14. These analyses are required, in part, to demonstrate compliance with the ECCS performance requirements of 10 CFR 50.46. The existing analyses, as discussed in the Updated Safety Analysis Report (USAR) Section 15.3.1.1, did not appear to include a subset of very small break areas. USAR Section 15.3.1.1 states that the SBLOCA analysis covered a spectrum of breaks starting at 0.01 ft^2. A LOCA is defined as the break area from which the rate of fluid discharged cannot be matched by normal system makeup. The leak rate resulting from the rupture of a ½-inch schedule 160 instrument line (0.002 ft^2) is the largest break area matched by normal system makeup capability. Therefore, the spectrum of SBLOCA breaks from 0.002 to 0.01 ft^2 was apparently not analyzed based on an assumption that break sizes smaller than 0.01 ft^2 resulted in decreasing consequences. This could be problematic for very SBLOCAs that may repressurize the RCS above the HPI pump shutoff head when the minimum flow recirculation valves are closed. If the HPI pumps are not assured of injecting sufficient water into the RCS, the pump flow may not be adequate for thermal protection of the pump.

In response to this concern, the licensee contacted the Nuclear Steam Supply System (NSSS) vendor, Framatome. Break sizes between the capacity of the Makeup (MU) System and up to the 0.01 ft^2 range were not covered by the vendor's

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

DESCRIPTION OF OCCURRENCE (continued):

existing SBLOCA analyses. Framatome performed an analysis of these very small breaks utilizing the NRC-approved version of the ECCS evaluation model (EM).

The application of the EM, which includes very conservative assumptions, predicted that cyclic repressurization of the RCS would occur prior to depletion of the BWST and continue following realignment of the HPI pumps to the emergency sump via the LPI pump discharge (piggy-back operation), after the recirculation valves are closed. RCS pressure during this condition was analytically predicted to exceed the shutoff head of the pumps. Without minimum flow through the pumps, they could be damaged from overheating in this potential deadhead operating condition and fail to perform their intended safety function. This condition has existed since the original design of DBNPS.

Notification of this condition was provided to the NRC on April 11, 2003 (Event No. 39750).

APPARENT CAUSE OF OCCURRENCE:

Immediately following the accident at Three Mile Island Unit 2 in March 1979, the NRC initiated an examination of slow RCS depressurization resulting from SBLOCAs. These SBLOCAs had not previously received detailed analytical studies comparable to those devoted to large breaks. A product of this NRC re-examination was NUREG-0565, "Generic Evaluation of Small Break Loss-Of-Coolant Accident Behavior in Babcock & Wilcox Designed 177-FA Operating Plants." In NUREG-0565, the NRC concluded that "the small break analysis methods used by Babcock & Wilcox (B&W) are satisfactory for the purpose of predicting trends in plant behavior following small break LOCAs and for training of reactor operators," but concerns regarding the small break model were identified. NRC recommendations included that analysis methods be revised and submitted for NRC approval, and plant-specific calculations using the NRC-approved model for small breaks should be submitted to show compliance with 10 CFR 50.46.

According to the NRC, B&W had performed a sufficient spectrum of SBLOCA analyses to identify the anticipated system performance for breaks in this range. However, in response to NRC concerns, B&W modified their small break model to allow more detailed consideration of the top of the hot leg piping 180 degree bend entering the once-through steam generator (OTSG) vessel. Because this is the highest point in the system, a large steam bubble would probably occur causing an interruption in natural convection flow in the RCS leading to repressurization of the RCS. For the DBNPS raised reactor coolant loop design, B&W analyzed a small break size of 0.01 ft^2. This analysis predicted cyclic loss of natural circulation in the RCS due to very slow depressurization of the system by leakage out of the small break. This results in a system repressurization phenomenon as stored decay heat energy heats up the inventory in the reactor.

APPARENT CAUSE OF OCCURRENCE (continued):

The discussion of the B&W analysis and predicted results in NUREG-0565 recognizes that DBNPS has lower shutoff head HPI pumps than other B&W plants. The NRC was concerned with this unique design as it related to potential loss of Auxiliary Feedwater (AFW) during the SBLOCA sequence. However, the NRC noted in the NUREG that operator action to manually initiate AFW would be needed. (Current plant configuration results in AFW automatic actuation upon securing of all four Reactor Coolant Pumps.) For the loss of AFW event without a break, other operator actions were credited by the B&W analyses such as manually opening the pilot-operated relief valve (PORV) and use of the Makeup (MU) pump to prevent uncovering the core. For 10 CFR 50.46 analytical purposes, these same operator actions are not credited for SBLOCA. The NRC stated that DBNPS SBLOCA emergency procedures had been modified to incorporate these actions.

The concern, as expressed in NUREG-0565, was assuring the core remained covered during SBLOCA. Although it was recognized at the time that the DBNPS HPI pumps had a lower shutoff head than other B&W plants, there was not an apparent correlation of this to RCS repressurization events that may result in the pumps experiencing shutoff head while taking suction from the emergency sump via the LPI pump discharge.

Based on review of the revised B&W model and analytical results, the NRC recommendations included upgrading the reliability and redundancy of the equipment used to actuate the PORV and its Block Valve to comply with the requirements of NUREG-0585 regarding interaction of safety and non-safety systems. As discussed in DBNPS correspondence addressing Feed and Bleed Modifications and responses to Generic Letter 90-06(Serials 1836, 1884, and 2128), various upgrades to the design of the PORV, the Block Valve, and the MU System were effected at DBNPS to improve their reliability. In addition, plant simulators should offer SBLOCA events resulting in repressurization. These sequences are included in procedure DB-OP-02000, "RPS, SFAS, SFRCS Trip, or SG Tube Rupture," and are included in operator simulator training.

The Evaluation Model of Framatome Topical Report BAW-10192P-A was applied to the specifics of DBNPS, and an analysis was performed which is summarized in Framatome ANP 86-5006232-01, "DB-1 LOCA Summary Report." This report was issued in March 2000. Revision 22 to the USAR 6.3.3 discusses the evaluation results of this report. This Summary Report indicates that the repressurization phenomenon would occur during the injection mode of operation when the HPI pumps have minimum flow recirculation. However, AFW cooling in conjunction with intermittent HPI injection would result in adequate long-term depressurization of the RCS long before the BWST would be depleted and, therefore, before the recirculation valves would be closed. The Summary Report indicated that for a 0.01 ft^2 break size, initial repressurization would occur that would be well above the shutoff head of the HPI pumps. Following that, smaller repressurization cycles would occur, but RCS pressure would then drop off continuously. The results of the 0.01 ft^2 break analysis were determined to meet the acceptance criteria of 10 CFR 50.46, and Framatome concluded that with OTSG heat transfer available, the consequences of the small break transient decrease

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APPARENT CAUSE OF OCCURRENCE (continued):

with decreasing break size. Therefore, break sizes smaller than 0.01 ft^2 were not specifically analyzed.

Following the questioning during the fall 2002 NRC inspection of a potential deadhead condition of the pumps and the adequacy of thermal protection for the pumps, Framatome performed a study for DBNPS to determine whether HPI pump operability during post-LOCA sump recirculation could be assured for all break sizes and transient scenarios. A range of break sizes from 0.00206 ft^2 (leak-to-LOCA transition area) to 0.0045 ft^2. This range of break sizes is less than the area typically included in SBLOCA analysis spectrum range (0.01 to 0.75 ft^2). The study concluded that for the range of break sizes analyzed, past operability of the HPI pumps was a concern from an analytical perspective since, according to regulatory requirements, no credit is taken for the mitigative benefits of non-safety grade equipment and only limited operator actions are credited. The previous EM would not predict the same concern.

In summary, the SBLOCA analysis was originally performed for DBNPS during original plant design and licensing in accordance with the requirements of 10 CFR 50.46 and incorporating the conservative assumptions of 10 CFR 50, Appendix K, "ECCS Evaluation Models." The original DBNPS analysis was based on a May 1972 model. The SBLOCA EM and analysis have undergone revision over the ensuing years based on improved analytical techniques. The analytical results currently presented in the USAR are based on a July 1998 EM. This version of the EM applied to DBNPS was described in the Framatome "DB-1 LOCA Summary Report" which was issued in March 2000. The EM and its evolution are generally described in USAR Section 6.3.3.1.1. That description notes that while the large break LOCA EM has had only minor changes since the original licensing calculations were performed, the EM for SBLOCA has had several changes.

ANALYSIS OF OCCURRENCE:

The following scenario describes a purely analytical event in accordance with NRC requirements of 10 CFR 50.46 and Appendix K. The Framatome LOCA Summary Report currently contained in the DBNPS USAR includes analysis of SBLOCAs that may allow RCS repressurization while HPI pumps are injecting from the BWST to the RCS. During this operation, thermal protection of the pumps is provided by a minimum flow recirculation line. With heat transfer to AFW in the OTSG, RCS depressurization would be accomplished, and the pressure limit of the HPI pumps would never be challenged. The small break areas analyzed were over the range of 0.01 to 0.75 ft^2. However, based upon the November 2002 reanalysis of possible transient scenarios for break sizes smaller than those typically included in the SBLOCA analysis spectrum range (i.e., greater than 0.01 ft^2), it may be possible for interruption in natural circulation to occur that leads to RCS repressurization above the minimum HPI flow pressure criterion (1750 psia). This repressurization phenomenon can become cyclic as predicted by the analysis, lasting from 12 hours to several days when the classical 10 CFR 50, Appendix

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ANALYSIS OF OCCURRENCE (continued):

K assumptions are credited. If the minimum flow is not preserved, the pump could be damaged such that continued operability is no longer assured.

Although operator actions are procedurally directed for actual events, the Appendix K LOCA analyses have substantial prescribed conservatisms, use only full safety-related equipment, consider the worst single failure, and make very limited use of operator actions. In the case of DBNPS, no credit is taken in the analysis for the mitigative benefits of highly reliable but non-safety grade equipment such as the PORV, PORV Block Valves, and MU pumps. The MU pumps are capable of providing continuous flow to the RCS from the BWST. Continuous operation of the MU pumps would protect the HPI pumps by assuring that subcooled natural circulation of the RCS could be restored long before the BWST inventory is depleted. Opening of the PORV and its Block Valve increases the RCS equivalent break area by at least 0.01 ft^2. This ensures that the RCS would not repressurize above the shutoff head of the HPI pump.

This type of accident is a slowly evolving transient which is included in the plant's emergency operating procedures. Framatome calculated the range of break sizes of interest to be 0.00206 to 0.0045 ft^2. The minimum time to switch the HPI pump suction from the BWST to the emergency sump was calculated to be approximately 24 hours. For the smallest break area simulated, the switchover time was calculated to be approximately 92 hours. Plant operators are trained in the actions necessary to mitigate the accident prior to entering an RCS repressurization condition that would challenge HPI pump operability. Based upon the analytical results, substantial time would be available to execute accident mitigative actions.

In addition to the actions described above, other potential mitigative options are available to the operators. These would include depressurization of the OTSG by opening the Atmospheric Vent Valves, cycling the HPI pumps to avoid RCS repressurization challenging their shutoff head, and reopening the HPI pump recirculation valves. For analysis purposes, all of the reactor core fission products are assumed to be released to the coolant. Therefore, recirculation of this potentially radioactive fluid from the emergency sump to the BWST would have unacceptable offsite dose consequences. However, for the SBLOCA event, there should not be any failed fuel, and the dose consequences of reestablishing pump recirculation flow to the BWST should be minimal. The foregoing potential mitigative options are currently under evaluation.

Because of the availability of highly reliable equipment to quickly mitigate the postulated accident and the substantial response time available for operators to implement actions in accordance with plant emergency procedures, the increase in core damage frequency (CDF) from this analytical prediction was preliminarily estimated to be 5E-9 per year. This represents a very small contribution to the overall CDF of 1.22E-5 per year and is not risk significant. This CDF increase may change as further examination of the thermal hydraulics of this event continues.

LICENSEE EVENT REPORT (LER)

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CORRECTIVE ACTIONS:

This condition of analytical results and postulated consequences is being reported as

- a change that results in a calculated ECCS performance as predicted by the 50.46 analysis that does not conform to 50.46(b)(5) in accordance with 50.46(a)(3)(ii),

- a condition resulting in an unanalyzed condition in accordance with 50.73(a)(2)(ii)(B),

- a condition resulting in a loss of safety function in accordance with 50.73(a)(2)(v), and

- a condition which creates a common mode failure in accordance with 50.73(a)(2)(vii).

The re-analysis which predicts the cyclic RCS repressurization phenomenon for very SBLOCAs is being further evaluated to validate the plant-specific application at DBNPS. Based on the results of this further evaluation, several corrective options may be considered which can include plant equipment upgrades and/or procedure enhancements. Appropriate corrective action(s) will be addressed in a supplement to this LER to be submitted.

As a related issue, the NRC requested on November 21, 1979, additional information regarding protection of HPI pumps should RCS repressurization occur causing the pumps to deadhead. The DBNPS response was provided on December 28, 1979 (Serial 568). The response to Item #2 of this letter will be reviewed in light of the newly identified analytical prediction of HPI pump operation, and a revised response will be provided as appropriate by September 30, 2003.

FAILURE DATA:

In the previous two years, one LER (LER 2003-002) was submitted to the NRC involving potential inoperability of the HPI Pumps. LER 2003-002 addressed the potential harmful effects to the pumps of debris entrained in the pumped fluid which is a different issue than addressed in this LER. During this same time period no LER was submitted with respect to the 10 CFR 50.46 accident analysis.

Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

NP-33-03-003-00	CR 02-06702	CR 02-08915
	CR 02-09159	CR 03-02876
	CR 03-03848	